

The Status Of Forest Genetics And Tree Improvement In The USA

Ron Schmidting

USDA Forest Service; Southern Institute of Forest Genetics, Saucier, MS 39574

RSchmidting@fs.fed.us

This report was originally prepared for the 25th meeting of the Forest Genetics Resources Working Group (FGRWG) of the North American Forest Commission (FAO) (see the poster abstract for the FGRWG in this Proceedings). These reports are written for each meeting for each of the three countries involved: the US, Mexico and Canada. The reports have previously not been circulated outside of the Working Group, but there is always information of general interest in the reports, hence its inclusion in this Proceedings.

The years of budget cuts and down-sizing seems to have abated, but our optimism is tempered by attacks by eco-terrorism groups such as the Earth Liberation Front (ELF). A session of this SFTIC meeting was devoted to the subject. These groups have been around for some time, but have expanded their activities beyond attacks on the deployment of Genetically Modified Organisms (GMO's) to include just about anything that they consider "unnatural". Most of these new Luddites, like the old, are not blessed with great intelligence. They are not capable of distinguishing between GMO's, conventional breeding, silviculture or conservation reserves.

The seriousness of the threat is outlined in a recent issue of Science (Service 2001). Toby Bradshaw's lab at the University of Washington was destroyed on the 21st of May, along with "collateral damage" to many other unrelated research projects. The same night, buildings were burned and vehicles damaged at Jefferson Poplar Farms in Clatskanie, OR. In mid-March, over 800 poplar trees were destroyed at Steve Strauss's lab at Oregon State (Kaiser 2001). Don Riemenschneider's program suffered serious losses the 20th of July, 2000 (see below under North Central Forest Experiment Station).

As is common with most terrorists, reasoning or debate does not seem to have an effect. Some effort in public relations may sway people who feel some sympathy for the goals of these groups but who would not otherwise participate in the terrorist acts. Increased security and law enforcement seem to be the best alternatives.

US FOREST SERVICE

The decline in tree improvement activity in the National Forest System appears to have bottomed out. Tree improvement units are shifting emphasis to problems such as genetic diversity, and are therefore better able to justify their programs. It remains to be seen how the recent elections will affect genetics and tree improvement. There does seem to be a shift in emphasis back to timber production, which will require more planting stock.

Programs in Forest Service Research have also been greatly affected by cuts in funding and manpower, but appear to be on the way back up. Research units have managed to diversify and engage in more multi-disciplinary research. In spite of down-sizing, the federal segment is still a major portion of the forest genetics and tree improvement effort in the US.

Presented at the 26th Southern Forest
Tree Improvement Conference,
Athens, GA, June 26-29, 2001.

Washington Office

Down-sizing has significantly affected Washington office staffing as well as staffing in the field locations. Vacant staff positions, however, are being filled. Stan Barras [Forest Pathology Research Program Leader] had assumed many of the duties assigned to Calvin Bey, but has now retired. Sharon Friedman and Les Whitmore are now sharing the duties in silviculture, including genetics (Friedman) and physiology (Whitmore). Les has retired, however, effective January 3001.

On the National Forest side, Safiya Samman has assumed the staff duties for genetics. Clark Lantz, who was the national coordinator for genetics for State and Private Forestry has retired, leaving only Ron Overton in that capacity. George Hernandez has assumed some of Clark's duties in Atlanta. His primary interest is nurseries, however.

Research Stations

Northeastern Forest Experiment Station

The forest genetics research program which has been active since the 1920's in the Northeastern Station is lapsing into a state of dormancy. The last remaining geneticist in the Station, Peter Garrett, has retired and will not be replaced. Pete still remains active as a volunteer, however.

On the positive side, the more important long-term genetics work will be maintained as a separate problem area in the newly constituted work unit NE-4155, Ecology and Management of Northern Forest Ecosystems. The project leader, John Brissette, was a student of Jim Hanover at MSU, so he undoubtedly has a good understanding of the importance of genetics.

North Central Forest Experiment Station

The Station has two remaining research projects dealing with genetics, one located at Rhineländer, Wisconsin and one at Purdue University, which is a joint effort between the state of Indiana, Purdue, USFS, industry and other cooperators.

Don Riemenschneider now has his own RWU but does not have any additional scientists in the unit. He is focusing on *Populus* breeding. He has a new cooperative centered in Minnesota and is working on a multi-pronged strategy including pure *P. deltoides* recurrent selection, F1 interspecific hybrid breeding and advanced generation backcross breeding with *deltoides* as the recurrent parent and black cottonwood as the non-recurrent parent. He has somewhere between 30K and 50K new progeny in his breeding nurseries or in field test. His regional clonal trials are beginning to show (small plot) yields in excess of 7 tons per acre per year (dry weight stem and branches) at age 6 years on good agricultural sites.

The Earth Liberation Front visited his research nursery last July. A number of plots containing poplar and jack pine populations were damaged by chopping off the small trees or by girdling the large ones. The most significant damage was to a population of *P. trichocarpa* that he had been working on for 20 years. He had selected for resistance to *Septoria* canker and had 30 clones reaching flowering size. This would have been the foundation for a *P. deltoides* x *P. trichocarpa* breeding effort. The girdled trees resprouted immediately, but as is the case with coppice resulting from summer harvest, the plants did not survive the winter. The genotypes were replicated, and thus not lost but none of the new plantings are anywhere near flowering age. They had no GMO trees in the tests - but that didn't seem to make a difference.

Charles Micheler's unit in Rhineländer (RWU-4155) was closed at the end of FY2000. Craig Echt took a job at New Zealand Forest Research Institute in Rotorua. Micheler has relocated to West Lafayette as Director of the Hardwood Tree Improvement and Regeneration Center. He

has two other FS scientists: Keith Woeste and Paula Pijut. Keith has initiated a breeding program for black walnut (continuing the work of Walt Beineke), black cherry and American chestnut. Keith is developing SSR markers for marker-assisted selection. He is selecting for form, growth rate, disease resistance, and percent heartwood. In his work with American Chestnut, he is growing and screening Indiana American Chestnut x American Chestnut Foundation blight resistant pollen. Paula has relocated from St. Paul, MN and will work on vegetative propagation and nursery production research.

Rocky Mountain Research Station

Dennis Ferguson is project leader of RMRS-4153; Silviculture and Genetics of Rocky Mountain Forest Ecosystems. Jerry Rehfeldt (Research Geneticist) is working on: a) the genetic structure of the spruce complex (*P. engelmannii*, *P. glauca*, *P. mexicana*, and *P. pungens*) of the Intermountain West, b) the genetic structure of the *Ponderosae* subgroup of genus *Pinus* with emphasis on genetic variation among taxa, variation among populations, and variation within populations of *P. washoensis*, *P. engelmannii*, *P. arizonica*, *P. durangensis*, and *P. ponderosa*, c) genetic variation in minor species: *Cupressus arizonica*, *Pinus leophylla*, and various taxa listed above, d) using response functions to predict the effects of changing climates on adaptability of populations, and e) genetic variation among populations of *Nothofagus nervosa* of northwest Patagonia and their adaptation to the mountains of the interior northwest of the U.S.

Donna Decker-Robinson (Research Geneticist) is carrying on the rust resistance work with western white pine, specifically the mechanisms of resistance and the physiological basis of resistance to blister rust. Her new work involves the ecological genetics of whitebark pine that are resistant to blister rust.

Southern Research Station

All of the remaining genetics work from the old Southeastern and Southern Stations (now merged into the Southern Research Station) is located in one administrative unit, SIFG, the Southern Institute of Forest Genetics (SRS-4153), located in Saucier, Mississippi, 20 miles north of the Gulf Coast. Floyd Bridgwater is project leader. The staff includes research geneticists Ron Schmidling, Floyd Bridgwater (located at Texas A&M), Tom Kubisiak, and Jim Roberds, who was formerly with Gene Namkoong in Raleigh. The project is recruiting replacements for several positions. The staff also includes research plant physiologist Alex Diner, who is located at the University of Florida.

Since genetics research has been conducted at the Institute for more than 50 years, research personnel have a great many long-term studies and pedigrees to draw upon for study material. Research is carried out in the more traditional areas of research such as provenance testing (including geneecology), progeny testing and breeding theory, as well as population genetics and pollination biology. Embryo culture and clonal propagation techniques have also been explored to support work on the biology of fusiform rust.

Recently initiated molecular work continues to contribute to disease resistance breeding in pines as well as in American chestnut. Molecular techniques are also being used to study the population biology of the host-pathogen relationship of fusiform rust as well as for determining phylogenetic relationships and examining gene-conservation issues.

SIFG was recently placed on an ELF "hit list", probably because they had (for a short time) a web site with the words "genetic" and "DNA" on the site. They do not have any GMOs.

Pacific Northwest Research Station

Brad St. Clair is project leader of the Resource Management and Productivity Program located in Corvallis, Oregon. Presently the genetics team is Brad, Randy Johnson, and a new scientist who will be on board in August. Rich Cronn. Rich is a population geneticist with a strong molecular genetics and evolutionary biology background. Randy and Brad are quantitative geneticists. Brad's research is predominately concerned with genecology, gene conservation, genotype x shade interactions, and realized genetic gains. Randy's research is predominately concerned with genecology, Swiss needle cast tolerance, and tree breeding and testing strategies. Frank Sorensen still comes in a lot, finishing up some of his genecology studies. Don Copes comes in occasionally, continuing with some of his seed orchard research including doing crosses to maintain seed stores of graft compatible rootstocks. Roy Silen also still comes in, writing up the long-term studies he has been working on.

Work is divided among four problem areas: (1) genetic architecture / genecology, (2) resistance to biotic and abiotic stresses, (3) integration of genetics and silviculture, and (4) management and conservation of genetic resources.

Pacific Southwest Research Station

The Institute of Forest Genetics (IFG, PSRS-4103, Placerville and Davis, CA) remains a major center for research on the genetics of forest trees. Tom Conkle and Jim Jenkinson have retired, but are continuing some projects as emeritus scientists. Dave Neale is now project leader, and his staff includes Research Geneticists Tom Ledig, Bohun Kinloch, Claire Kinlaw, Andrew Grover, Det Vogler and Connie Millar.

Research is centered on two main areas, molecular genetics and conservation genetics. Tom Conkle and Tom Ledig continue to work on the application of allozymes to the conservation of genetic resources and seed zoning. Both are involved in studies of Mexican conifers. Conkle is working on problems of introduced exotics in Hawaii, and on the genetic structure of native species there such as koa. Ledig is leading a program on genetic improvement of cork oak in Portugal, and is also working on California conifer species.

Connie Millar is working in the area of conservation genetics, and has opened a new problem area in relating past and future genetic change to changes in paleochromate. She is also serving as the key scientist in the Sierra Nevada Ecosystem Assessment Project. Robert Westfall supports the program in quantitative genetics and biometry.

Kinloch's work on the host-pathogen relationship of white pine blister rust embraces both conservation genetics and molecular biology. David Neale and Claire Kinlaw lead the molecular genetics program and head the National Tree Genome Mapping Project, maintaining the genome data base and publishing *Dendrome*.

Other resident emeritus scientists include Ron Lanner, retired from Utah State, Raj Ahuja, retired from the German Institute of Forest Genetics, and Robert Scharpf, a pathologist retired from PSW.

National Forest System

Northern, Rocky Mountain, Southwestern, and Intermountain Regions- R1, R2, R3, and R4

Mary Frances Mahalovich, Geneticist in Moscow, ID, administers the Genetic Resource Programs in R1-R4 under a shared services agreement formalized in 1996. R1 has been active in tree improvement for 45 years, Selective breeding for western white pine blister rust resistance remains one of the more active programs. Controlled crossing to generate the second generation testing population began in 1995, and is ongoing in cooperation with the Inland Empire Tree Improvement

Cooperative. Completion of the first generation testing program will be accomplished around 2010. Testing, seed orchard, and clone bank establishment is active in western larch and ponderosa pine. Activities in Douglas-fir and lodgepole pine are limited to protecting existing long-term tests and establishing clone banks until there is a need for planting stock. Establishment- of ponderosa pine seed orchards and clone banks is ongoing in R4, to meet reforestation and restoration needs of southern Idaho.

Catastrophic fire in 2000, in much of Montana particularly at high elevations, has rekindled (sorry for the pun) the tree improvement work and interest in developing a reliable cone crop for ponderosa pine. Loss of the whitebark pine community type due to fire, blister rust and mountain pine beetle, also received national attention. FY01 marked the beginning of a whitebark pine restoration and blister rust improvement program with fire monies (Title IV funding)--a joint effort in R1, R2, R4, eastern R6, and the National Park Service. The rest of Mary Frances' time is spent in developing seed transfer guidelines and expert systems in cooperation with RMRS for **conifer** species and more recently for native plants (shrubs, forbs, and grasses), assisting Forests in planning their operational and restoration cone/seed collections based on a good genetic base, and identifying and developing remedial action for off-site seed sources to maintain the native gene pool and improve forest health conditions in the Inland West Regions. This work is also being extended to mining reclamation.

Pacific Southwestern Region - R-j

Jay Kitzmiller is the Regional Geneticist in San Francisco, CA. Safiya Samman has left to take a staff position in Washington. A major program in tree improvement began in the Region about 20 years ago, emphasizing commercial timber species. Recently the program was expanded to include the genetic aspects of biological diversity and on the consideration of genetics in ecosystem management. Budget cutbacks have caused large-scale reductions in tree improvement programs. The ponderosa pine, Douglas fir and white fir programs have been reduced to minimal maintenance levels to maintain genetic resources in orchards, clone banks and progeny tests.

Programs still active include blister rust testing of sugar pine and other western white pine species, and a cooperative program for selecting for disease resistance in Port Orford cedar, and a breeding effort in ponderosa and Jeffrey pines for resistance to dwarf mistletoe.

Valerie Hipkins is the director of the National Forest Genetics Electrophoresis Lab. (NFGEL). The lab is located at the Placerville, CA, nursery, but is moving down the road to IFG in October. NFGEL provides service for all of the regions, as well as some of the research stations, other federal agencies, universities and state agencies. Their work has shifted away from such things as identifying clones in seed orchards towards examining issues of genetic diversity in commercial timber species as well as in non-commercial species.

Pacific Northwest and Alaska Regions - R-6 and R-10

Sheila Martinson is the Regional Geneticist located in Portland, OR. Geneticists include Richard Snieszko, Carol Aubry, Tom Despain, Vicki Ericson, David Dodee, Jim Hamlin and Paul Berang. This program has also been severely hampered by budget cuts. The greatest emphasis has been on Douglas fir in the past, and the investment in this species will be maintained.

Priorities have now shifted to breeding for disease resistance; blister rust in sugar pine and white pine and *Phytophthora* root rot in Port Orford cedar. There is also an effort to produce seed for seral species such as western larch and ponderosa pine on the east side of the region. There is no tree improvement for Alaska.

Southern Region - R-5

Geneticist Tom Tibbs is located in Atlanta, GA. Tim LaFarge recently retired and left Atlanta. Zone geneticist Jim Gates retired and was replaced by Jerry Windham on a part-time basis. This program, like those in other regions, has been severely reduced in funding and manpower, because of greatly diminished needs for planting stock. The last remaining federal nursery in the south, the Ashe Nursery in south Mississippi, is scheduled to be either closed, or turned over to a contractor.

The orchards and progeny tests are being minimally maintained, to preserve the 35-year investment in the program. Even without a tree improvement program, these all have value as repositories of genetic material. Very little seed is being harvested in the orchards. Emphasis is shifting to species that are difficult to regenerate naturally, such as longleaf, shortleaf, pitch and sand pines, and species that are endangered by disease or insects, such as butternut hickory, hemlock and oaks.

The Bent Creek Resistance Screening Center located in Asheville, NC (Carol Young, Director) continues to screen southern pine families for resistance to fusiform rust.

Eastern Region - R-9

Located in Rhinelander, Wisconsin, Dick Meier serves as the Regional Geneticist and Bill Sery is the Geneticist in charge of the Oconto River Seed Orchard in Wisconsin. The bulk of the activity remains in the Lake States. Nursery production is now stable at about three million bare root seedlings and a half of a million containers annually. Almost all of the planting is in the Lake States. Almost all of the genetic work is centered on white and jack pine. White pine is being screened for resistance to white pine blister rust and jack pine is being bred for growth and form.

The Eastern portion of the region continues to measure progeny tests and is relocating select trees and adding GPS as an aid in future location. The Central portion of the region has just finished thinning their shortleaf pine orchard for the first time and is resuming progeny testing of their selections with control crosses made several years ago. The Forest Service will share seed from their orchard with the State of Missouri.

Genetics is gaining popularity as a portion of the variability necessary to maintain population viability. Genetics is also now of concern in all planting, not only tree species. Seed source and adaptability are of primary concern.

The impending retirements of both geneticists in the region is requiring the Region to rethink the delivery of its tree improvement and genetics programs.

NON-FEDERAL PROGRAMS

State Government

Most states in the eastern United States have some tree improvement activities. In the northeast, the state programs are oriented more toward restoration forestry than production forestry, and seed source certification is an important issue being addressed by geneticists. State programs in the southeast are generally oriented more toward production forestry, and many of the states are members of tree improvement cooperatives. Nursery production has declined in all states because of a preference for natural regeneration. A few of the western states have tree improvement programs.

Forest Industries

In contrast to the national and state programs, most of the larger forest product industries have active and expanding tree improvement programs. Industrial members provide the core support for the tree improvement cooperatives, which in turn provide a considerable amount of funding for breeding and genetics research for the universities they are associated with. Those of us at the SIFG feel that the state and industrial cooperators are the primary user groups for our research.

Industrial research programs are very active in the area of biotech. The size of the research staffs, such as those of International Paper Co. and Weyerhaeuser tend to fluctuate. The exception to this has been Westvaco's program, which has always been strong and steady, and has recently expanded. Unfortunately, much of the information generated by industry researchers is not available outside the companies.

The tree improvement Cooperatives, such as the NC State, Florida and Texas A&M cooperatives in the south, and the Inland Empire in the west, remain strong and viable, and their associated universities provide a great deal of research support. There has been a turnover in personnel in the coops, mainly due to retirement. In the Texas Coop, Tom Byram replaced Bill Lowe as director and in the NC State Coop Tim Mullin replaced Bob Weir as director. Lauren Fins stepped down as director of the Inland Empire Coop, and was replaced by Marc Rust. Tim White remains as director of the Florida Coop.

Universities

Universities are continuing to support forest genetics, and some, such as the University of Georgia, have added to research staffs. Most recent positions have been filled by molecular biologists rather than quantitative or population geneticists. As a result, theoretical and applied support for breeding programs may be lacking. More basic research is being done on the genetics of woody plant species by biologists and botanists at universities because the new molecular techniques make it easier to work with species with long generation times.

In the Midwest, Ray Guries still works at the University of Wisconsin but his interests have migrated more towards development of pest resistant urban trees than development of forest crop trees. He does a lot of work advising Trent Marty with the Wisconsin DNR who maintains seed production populations of pines and spruces. Dave Karnosky is still working with Larch at Michigan Tech University in Houghton, MI.

In the West, Toby Bradshaw at the University of Washington and Steve Strauss at Oregon State are active in supporting tree improvement. Unfortunately, eco-terrorist groups such as the ELF are much more active in the Northwest, and their problems attest to this fact.

Some universities, such as the University of Minnesota, support local cooperatives. The Aspen-Larch Cooperative is still active in Grand Rapids, Minnesota and has a new geneticist - Andy David - on board. Andy is also directing the Minnesota Tree Improvement Cooperative at Cloquet, Minnesota. They are working through the advancement of their white spruce program to the next generation.

CONCLUSIONS

The future of forest genetics and tree improvement is uncertain, but this pendulum too, may be swinging in the opposite direction. The huge fires, especially in the west, are causing even the most hard-core environmentalists re-evaluate their positions on forest management (especially those whose houses were destroyed).

In the near-term it appears that the future of federal programs lies in examining questions of genetic diversity and gene preservation. Restoration forestry is becoming more popular. The industrial and university sector will have to lead the way in breeding and tree improvement. They seem to be far-sighted enough to realize that we will need to produce more forest products on less land, especially as it becomes more difficult to mine the tropical rain forests.

LITERATURE CITED

Kaiser, J. 2001. Words (and axes) fly over transgenic trees. *Science* 292: 34-36.

Service, RF. 2001. Arson strikes research labs and tree farm in Pacific Northwest. *Science* 292: 1622-1623.